Base-Catalyzed Transformations of Explosive Compounds in Soil and Water

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Contamination of groundwater, surface water and soil by explosives is a high priority concern of the U.S. Army. Explosive residuals from the manufacture and handling of explosive compounds, including TNT. RDX, and HMX, are found on numerous sites throughout the world. While technically feasible remediation technologies have emerged, complete remediation across the spectrum of contaminated sites remains cost prohibitive. Composting technology, while widely implemented, results in a significant volumetric increase and studies have shown that irreversible binding of transformation products, rather than mineralization, is the primary treatment phenomena.

A simple, rapid, and low-cost technology for detoxifying explosives is under investigation at the U.S. Army Engineer Research and Development Center. Application of lime, a common agricultural amendment, may develop into the soil remediation technology of choice to remove trinitrotoluene (TNT) from soil systems. Preliminary assessments indicate that addition of calcium hydroxide, a poorly water-soluble base, results in the loss of TNT over time. The potential effectiveness has been demonstrated on a number of site soils contaminated with TNT at a laboratory scale.

Results presented will include the kinetics of TNT degradation, the dependence of the rate of TNT degradation on temperature, the chemical properties of the transformation products, and the molecular weight distribution of the compounds produced as a result of TNT reaction with base in aqueous systems. Computational chemistry indicates likely transformation products of base induced transformation of TNT. These studies provide the fundamental background required to perform larger scale evaluations of base induced TNT transformation in representative site soils. Results of soil screening experiments will be presented that indicate the effectiveness of lime addition for the treatment of TNT contaminated soils. The key engineering parameters for large-scale implementation of lime addition for TNT transformation are currently being identified and optimized. The studies presented in this paper provide the fundamental background required to perform studies on base induced transformations of TNT in actual site soils.

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